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(19)

(54) IMPROVEMENTS RELATING TO TELECINE MACHINES

(71) We, BRITISH BROADCASTING CORPORATION, a British Body Corporate, of Broadcasting House, London, W1A 1AA, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:–

This invention relates to a method of and apparatus for detecting the presence of dust, hairs and other dirt as well as blemishes such as scratches and indentations on the surface of a cine film whilst it is running in a telecine machine.

Our Patent No. 1,409,153 discusses some previous solutions to the problem and discloses a method which can be used with a flying-spot telecine machine and which involves detecting the amount of light from the flying-spot scanner which is scattered by the film. However this method has some disadvantages.

Amongst these are the fact that it is only applicable to the flying spot type of telecine machine.

In accordance with this invention we provide a method of and apparatus for detecting imperfections on a film running in a telecine machine, in which the light passed by the film from a light source is detected to produce a television signal, as is conventional, and in which in addition the amount of infra-red radiation from the light source or from an additional source and which is passed by the film is detected and used to provide an electrical signal indicative of the presence of imperfections.

Such a system is applicable equally to different types of telecine machine. Preferably a single source (for example an incandescent lamp in a camera-tube machine) is used to provide both the light and infra-red radiation, and these can then be separated by a dichroic mirror or other suitable beam-splitting arrangement.

The transmission characteristics of the colour dyes used in present-day colour film are such that the infra-red radiation largely passes through the film unattenuated. The infra-red radiation is, however, stopped by dirt, and due to refraction and diffraction effects, by scratches also. It is therefore relatively easy to detect electrically those portions of the signal which indicate the presence of imperfections. This information can be used to substitute the affected areas of the picture by switching in some form of estimated picture information.

The invention will now be described in more detail, by way of example, with reference to the drawings accompanying the Provisional Specification, in which:–

Figure 1 is a diagrammatic side view of a telecine machine embodying the invention;

Figure 2 illustrates the removal of outlines from the video output; and

Figure 3 is a circuit diagram of a circuit for use in removing the outline which circuit can be used in the pulse shaping circuitry in the machine of Figure 1.

Figure 1 shows a source A of both visible and infra-red radiation, for example an incandescent lamp. This radiation is directed through a gate B through which a film C passes transversely, the film running between two spools C_1 and C_2. An image is formed by an optical system D onto an image sensor G which is a standard television image sensing device, or camera tube. The sensor G provides a video television signal.

As thus-far described the apparatus is entirely conventional and is typical of any camera-tube telecine machine.

In accordance with this invention a further scanning image sensor F is provided which receives the image formed by the optical system D after reflection in a dichroic mirror E positioned at 45 degrees to the optical axis. The dichroic mirror, being frequency selective, separates out and reflects

the infra-red radiation while passing the visible radiation substantially unaffected.

The sensor F is of a type which is sensitive to infra-red radiation, such as a silicon diode tube or a solid state image sensor.

The output of the image sensor F will thus be a two-level video type of signal which will have a high and approximately constant level where there are no imperfections in the picture and a lower level whenever the infra-red radiation is scattered or absorbed by imperfections.

The sensor output is applied to a pulse shaper U which consists essentially of an inverter and a threshold circuit and which provides a positive output whenever an imperfection is present. This signal can be used in many ways, and one example only is illustrated. In this example, the signal from the pulse shaper U controls the position of a high-quality electronic switch S one input of which is connected to the output of the video sensor G and the other input of which is connected through a delay T to its output, the latter constituting the output of the machine.

When no signal is present at the output of the pulse shaper U, the switch selects the output of the video sensor G as the output of the machine. However, if a signal is present at the output of the pulse shaper U, then the switch selects a substitute picture section, this being an adjacent previous piece of unblemished picture. This may come from a nearby area such as an earlier line or part of a line, or from an earlier picture, and the delay T has an appropriate delay time period.

As noted above, problems can arise with this and other systems resulting in outlines around the inserted substitute picture section. In particular the threshold in the pulse shaper U has to be set on the leading edge of the imperfection signal and will therefore fail to detect that part of the signal of level less than the threshold. This can be overcome by expanding the imperfection signal.

Reference is first made to Figure 2 which shows at (a) a dust particle or scratch which it is required to conceal. The signal from the infra-red detector F may correspond to the shape shown in full lines at (b) due to the failure of the threshold circuit to detect accurately the edge of the scratch, shown in dashed lines. The amount of error has, of course, been considerably exaggerated for clarity.

To overcome this the infra-red sensor F is moved relative to the video sensor G both in the vertical and horizontal direction as shown at (c). Now the signal is extended electronically in the horizontal direction by an amount approximately corresponding to double the amount of this misregistration and sufficient to exceed slightly the horizontal duration of the scratch, as shown at (d). Finally the signal is extended similarly in the vertical direction as shown at (e). It will be seen that the entire scratch will now be removed.

Figure 3 shows circuitry capable of effecting this extension, and which can be included in the pulse shaper U of Figure 1. The signal from the detector F (Figure 1) is applied to one input of a comparator H, to the other (inverting) input of which is applied a reference threshold voltage. The output of the comparator H is thus a two-level signal representing the location of any imperfections, but due to the relative shift between the sensors G and H the signal appears slightly ahead of the corresponding portion of the video signal from the sensor G, see Figure 2 at (c). The signal then proceeds through a series of delays I, J, ... K, L each of which provides a delay of one picture element. The number of these delays is determined by the amount of horizontal extension of the signal which is needed. The signals at the outputs of the comparator H and of all the delays I to L are applied to a logical OR gate M, the output of which is the signal represented at (d) in Figure 1.

The output of the OR gate M is now applied to a chain of delays N, O, ... P, Q each of which provides a delay of precisely one scanning line. The number of these delays depends on the required degree of vertical extension of the signal. The signals at all the points along the delay chain are applied to a logical OR gate R, the output of which represents the areas within which the dirt and scratches on the film are fully contained. This is the signal represented at (e) in Figure 2, and which is used to control the switch S in Figure 1.

In one example, with a conventional 625/50 interlaced PAL signal, we have found that a suitable amount of horizontal extension is about 500 nS and a suitable amount of vertical extension is 2 field lines.

It should be noted that when the circuit of Figure 3 is used to extend the imperfection signal obtained from a flying-spot telecine machine, it is no longer possible to misregister physically the infra-red optical images as represented in Figure 2(c). This is because no physical adjustment of registration is possible in flying-spot scanning systems. In this case, the misregistration illustrated in Figure 2(c) would have to be obtained by electronically delaying the optical image from the video sensor relative to the infra-red image. The circuit of Figure 3 can also be used in the pulse shaper 30 of our Patent No. 1,409,153.

The invention is applicable to telecine machines of this type which use a solid state line sensor to detect the image. Indeed, a solid state sensor would be particularly suit-

able as the infra-red sensor on account of its high infra-red sensitivity.

Attention is drawn to our Application No. 41548/78 (Serial No. 1547812) divided out of this Application.

WHAT WE CLAIM IS:-

1. A method of detecting imperfections on a film running in a telecine machine, comprising detecting the light passed by the film from a light source to produce a television signal, and detecting the amount of infra-red radiation from the light source or from an additional source and which is passed by the film to provide an electrical signal indicative of the presence of imperfections in the film.

2. A method according to claim 1, wherein when the said electrical signal indicates the presence of an imperfection, the corresponding portion of the television signal is replaced.

3. A method of detecting imperfections on a film running in a telecine machine, substantially as herein described with reference to Figure 1 of the drawings accompanying the Provisional Specification.

4. Apparatus for detecting imperfections on a film running in a telecine machine, comprising a source of light directed towards a film position, a light-responsive sensor positioned to receive light from the source which has passed through the film position, the light source and sensor co-operating to produce a television signal, an infra-red sensor arranged to detect the amount of infra-red radiation from the light source or from an additional source and which is passed by the film, and means for generating from the output of the infra-red sensor an electrical signal indicative of the presence of imperfections in the film.

5. Apparatus according to claim 4, wherein a single light source is used to provide both the light and infra-red radiation, and the light-responsive sensor is a camera tube, and including beam-splitting means for separating the radiation passed by the film and directing the visible radiation towards the camera tube and the infra-red radiation towards the infra-red sensor.

6. Apparatus according to claim 4 or 5, including means connected to the output of the light sensor and responsive to the output of the infra-red sensor to replace electronically the appropriate portion of the television signal when the said electrical signal indicates the presence of an imperfection.

7. Apparatus according to claim 4, 5 or 6, wherein the television signal from the light sensor is connected to the first input of a switch, the control input of which is connected to receive the said electrical signal.

8. Apparatus according to claim 7, wherein the switch has a second input connected to the output of delay means the input of which receives the television signal.

9. Apparatus for detecting imperfections on a film running in a telecine machine, substantially as herein described with reference to Figure 1 of the drawings accompanying the Provisional Specification.

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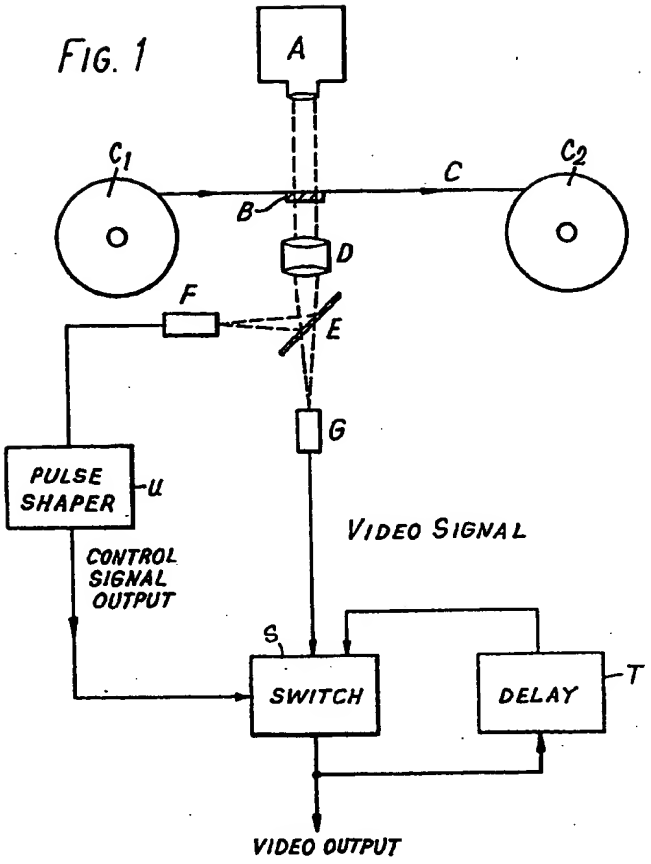
Sheet 1

FIG. 1



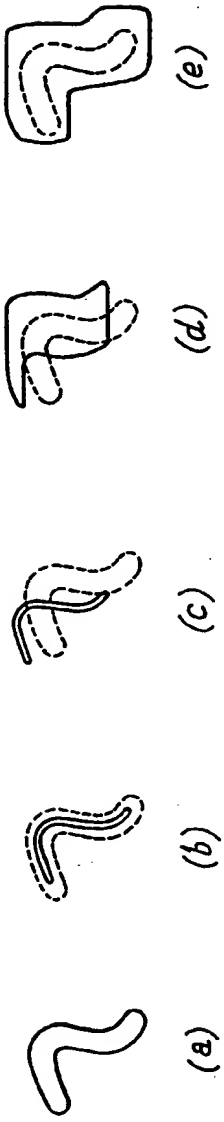


FIG. 2

1547811 PROVISIONAL SPECIFICATION
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FIG. 3